iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 8 **Issue:** X **Month of publication:** October 2020

DOI: https://doi.org/10.22214/ijraset.2020.31888

Comparative Analysis of Flat Slab with or without Perimeter Beam under Earthquake Load by Time History Analysis

Abhilash Jain[1], Prof. Kavita Golghate[2]
[1]PG Student, Department of Civil Engineering, Sushila Devi Bansal College of Engineering, Indore (MP), India
[2]Professor, Department of Civil Engineering, Sushila Devi Bansal College of Engineering, Indore (MP), India

Abstract: Multi-storey building for the commercial complexes is major requirement for the current scenario. For this large span and free space is required as per the need of the users. Due to this, these structures become challenges for structural engineer because large obstacle free space means less columns and greater spans which can result in a catastrophe. For this problem, a widely accepted concept has been introduced in the form of flat slab structures or beam less structures. To provide extra support column heads are introduced. Structural behaviour of these structures become complex under dynamic earthquake loading. Stability of this type of structure under such lateral loading must be checked before designing and construction of the building. In this articles deals with the different flat slab structures i.e. Flat slab structures with drop panels and without perimeter beams, Flat slab structures with drop panels and with perimeter beams uses fast non-linear time history analysis method. For this a regular commercial building having G+8 (32 m) is taken. Storey with a plan area 37.5 m x 37.5 m. is untaken for analysis in CSI-ETABSvr.2016 Software. The commercial building under taken in the earthquake Zone - IV for the city Rajkot in Gujarat. The non-linear dynamic analysis i.e. Time History approach used of Seismic response of the building. From the results it can be concluded that model 2 flat slab with perimeter used as optimized structure in the lateral stability under earthquake response.
Keywords: Flat Slab, CSI-ETABS, Drop panels, Perimeter Beams, Time History Approach

I. INTRODUCTION

In the recent era of industrialization commercial structures have become the backbone of market. These structures must be aesthetic appealing and must provide larger obstacle free space to attract the consumers. Due to this, these structures become challenges for structural engineer because large obstacle free space means less columns and greater spans which can result in a catastrophe. For this problem, a widely accepted concept has been introduced in the form of flat slab structures or beam less structures. These structures are different from conventional framed structures and slab rest on columns only. To provide extra support column heads are introduced. Flat slab structures can be constructed in many forms such as with or without drop panels or column heads. Using peripheral beams provides an extra type of the flat slabs. Stability of these structures under lateral earthquake loads should be checked before designing these structures.

Gravity loads resisted by transverse system of floors and then transferred to axial framing i.e. system of columns and column heads. Flexure and transverse shear developed in the floor systems. Floor can be considered as a diaphragm to stiffen and connect the columns and vertical elements. When this type of structure suffers lateral earthquake loading, then this diaphragm acts rigid and transfers the loads to vertical members.

For earthquake loading these type of structures must be analysed and designed accordingly. For analysis of earthquake force there are four methods which is used predominantly, Equivalent Static Analysis (ESA), Non-Linear Pushover Analysis (NLPA), Response Spectrum Analysis Method (RSM) and Time History Analysis (THA). Equivalent static method used when complexion and non-linearity is less, while push over analysis focuses on the non-linearity. But when the structure falls under the sensitive zone of earthquake than it is must to do dynamic analysis i.e., Response Spectrum (RSA) or Time History Analysis (THA). Present study deals with the dynamic analysis of flat slab building fall under the seismic sensitive zone of India. For this purpose Indian Seismic Design Code IS: 1893 has been used. To assess the structural performance of flat slab structures, a comprehensive comparative study has been done by using four different types of flat slab structures. Significance of drop panels has been considered with and without using the perimeter beams.

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 8 Issue X Oct 2020- Available at www.ijraset.com

II. MODELLING OF STRUCUTURE

For modelling of the building four major model are created.The considering types are as follows

1) *Model 1:* Flat slab with Drop panel and without perimeter beams.
2) *Model 2:* Flat slab with Drop panel and with perimeter beams.

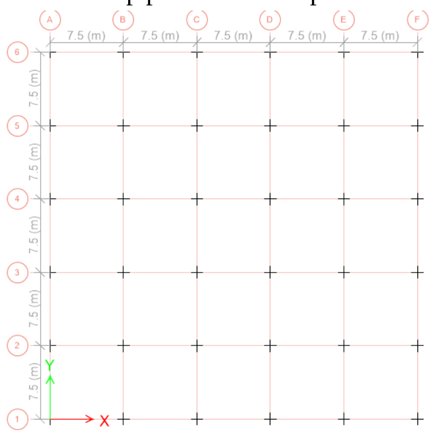


Fig. 1: Grid Line Plan

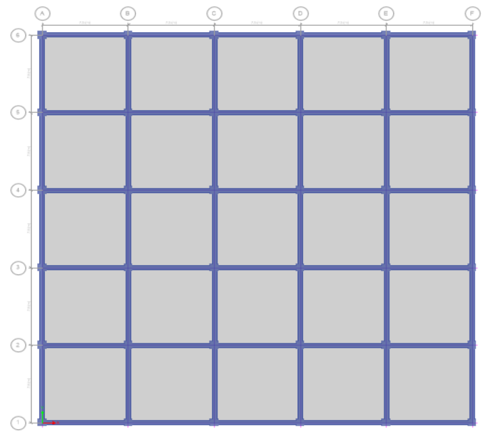
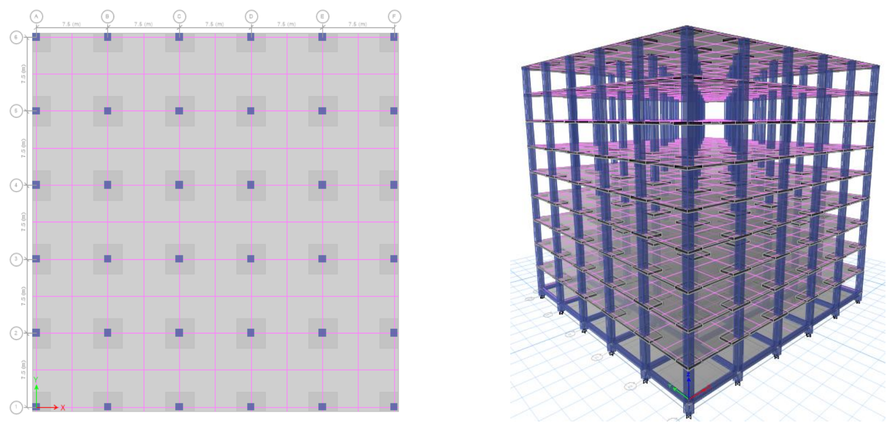
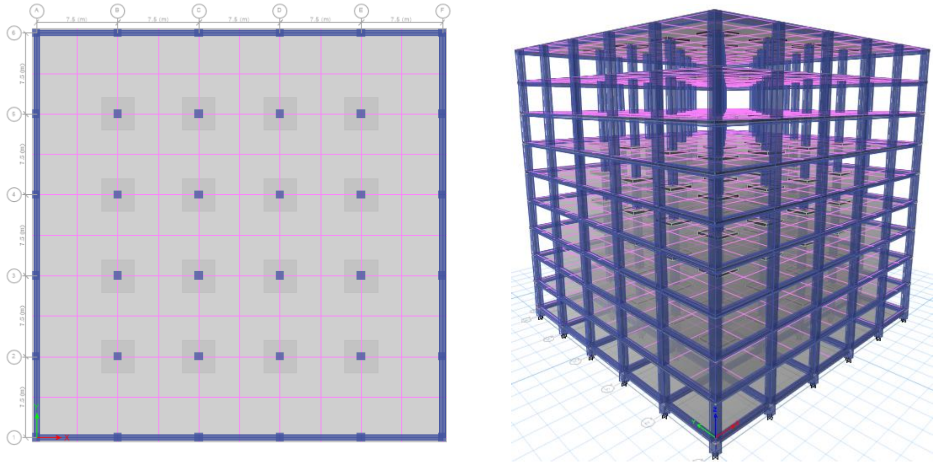


Fig 2: Plinth Floor Beam Plan



(a) Plan (b) 3-Dimensional Model

Fig 3: Model 1: Flat Slab with Drop & Without Perimeter Beam



a) Plan (b) 3-Dimensional Model

Fig 4: Model 2: Flat Slab with Drop & With Perimeter Beam

Table 1 Structural Properties

Structural Properties		
S.No.	Descriptions Of Parameters	Dimensions
1	Structure type	Rigid frame with flat slab
2	No of storey /total height	G+8/ 32 m.
3	Plan area	37.50 m x 37.50 m
4	Column size	750 mm x 750 mm
5	Perimeter beam size	500 mm x 700 mm
6	Plinth beam size	400 mm x 600 mm
7	Slab thickness	260 mm
8	Size of drop	3.00 m x 3.00 m
9	Thickness of drop (without slab)	75 mm
10	Overall thickness	335 mm
11	Spacing in grid in x – direction	7.50 m. c/c
12	Spacing in grid in y – direction	7.50 m. c/c
13	Individual storey height	4.0 m.

Table 2 Material Properties

Material Properties		
S. No.	Types of material	Dimensions / comments
1	Concrete (beam & column)	M-25
2	Concrete (Slab)	M-25
3	grade of rebar (R/F)	HYSD-500
4	ACC Block	650 kg/m^3

III.RESULT AND DICUSSION

Based on the modelling and Analysis on CSI ETABS software the following results are evaluated which are shown in tabulated and graphical forms.

A. Storey Displacement

Deflection of the stories from the initial position is termed as storey displacements and its maximum value is obtained at the top storey. The values obtained from the analysis have been shown in table 3 while graphical representation is described in fig 5.

Table 3 : Story Displacement results

Story	Model-1 (mm)	Model-2 (mm)
Base	0	0
Plinth	0.9	0.93
Ground	8.87	8.88
G+1	19.68	19.28
G+2	30.76	29.8
G+3	41.02	39.47
G+4	49.86	47.81
G+5	56.92	54.47
G+6	62.08	59.33
G+7	65.89	62.48
G+8	68.29	64.29

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 8 Issue X Oct 2020- Available at www.ijraset.com

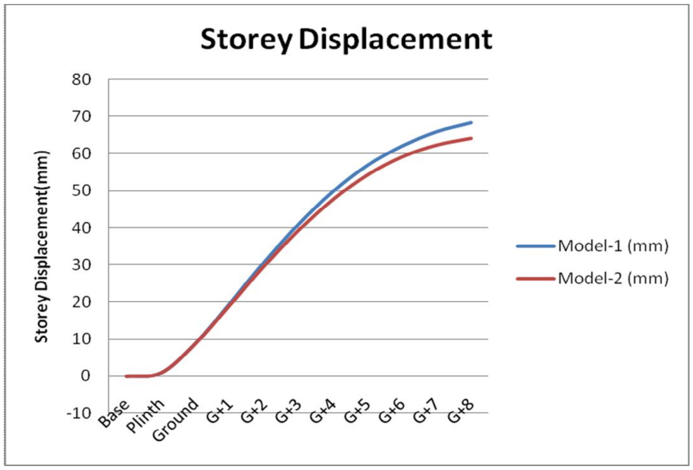


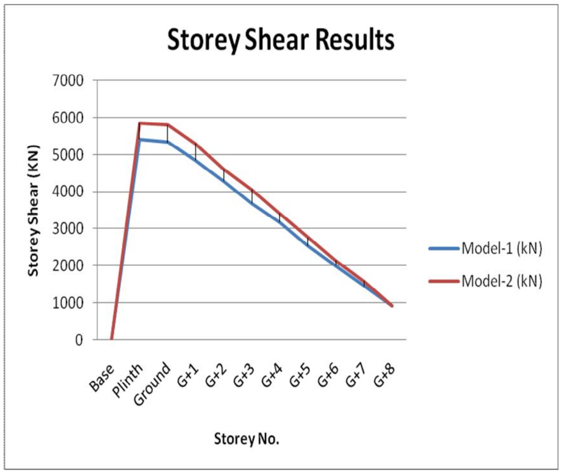
Fig. 5: Curve between storeys Displacement vs. no of storey

B. Storey Shear

In a building the seismic force is applied at each floor level then is termed as storey shear. Generally it is combination of deal load of structure and some part of live load of each floor level. The values obtained from the analysis have been shown in table 4.while graphical representation is described in fig 6.

Table 4 : Story Shear Result

Story	Model-1 (KN)	Model-2 (KN)
Base	0	0
Plinth	5408.73	5855.13
Ground	5327.51	5797.58
G+1	4848.34	5291.05
G+2	4285.71	4608
G+3	3682.8	4052.52
G+4	3175.23	3412.47
G+5	2541.1	2764.53
G+6	2014.97	2156.92
G+7	1458.14	1591.18
G+8	932.39	937.68



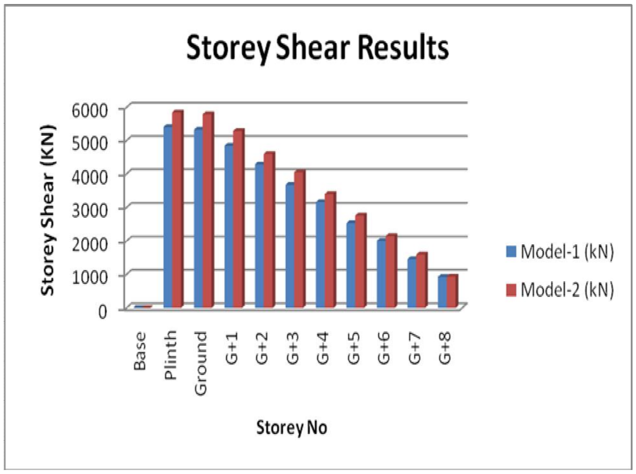


Fig. 6: Story Shear Result a) Curve between storey shear vs. no of storey b) Bar chart of storey shear

C. Base Moments

Moments at the base of the structure is termed as base moments. It depends on the magnitude of lateral forces and dead weight of the structure. For this study fast non linear analysis method of time history functions has been used. Based on this results are shown in table in X and Y direction. A bar chart representation of table 5 is shown in fig 7 below.

Table 5: Base moment Result

Storey	TH-X (KN.m)	TH-Y (KN.m)
Model-1	112945	112945
Model-2	123610	123610

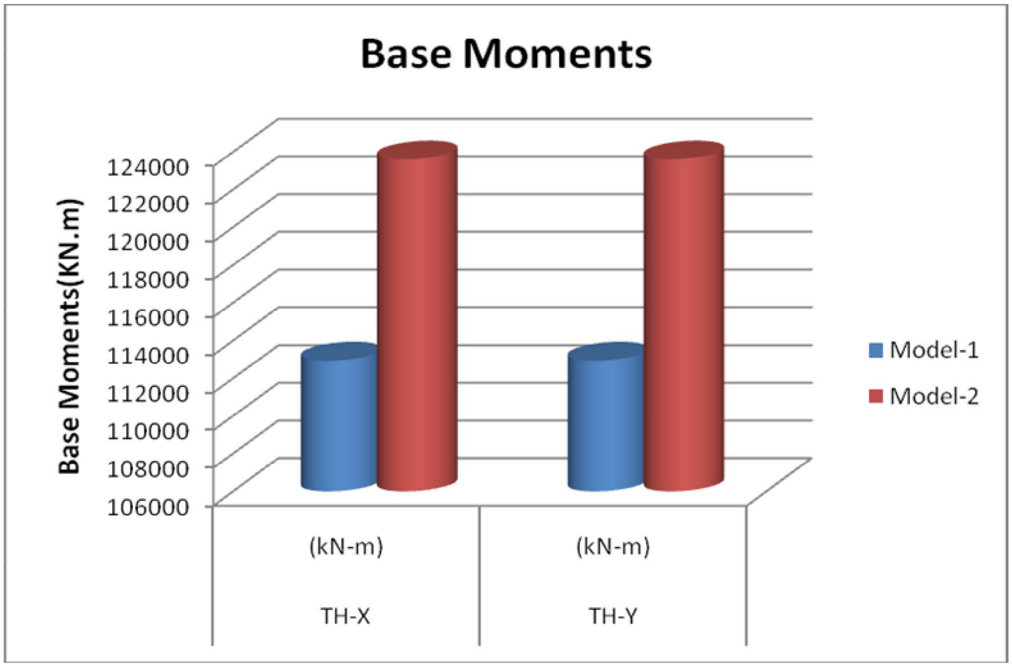


Fig. 7: Bar chart represent of base moment

D. Base Shear

Shear reaction forces at the base of structure due to lateral and gravity loads are termed as base shear. Base shear is used as designed forces, which means lower the base shear more economical the structure. Table 6 shows the Base shear for time history function maximum and minimum value.

Table 6: Base Shear Result

Base Shear				
Storey	TH-X_{max}	TH-X_{min}	TH-Y_{max}	TH-Y_{min}
	(kN)	(kN)	(kN)	(kN)
Model-1	5429.83	3986.45	5429.83	3986.45
Model-2	5855.13	4373.23	5855.13	4373.23

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 8 Issue X Oct 2020- Available at www.ijraset.com

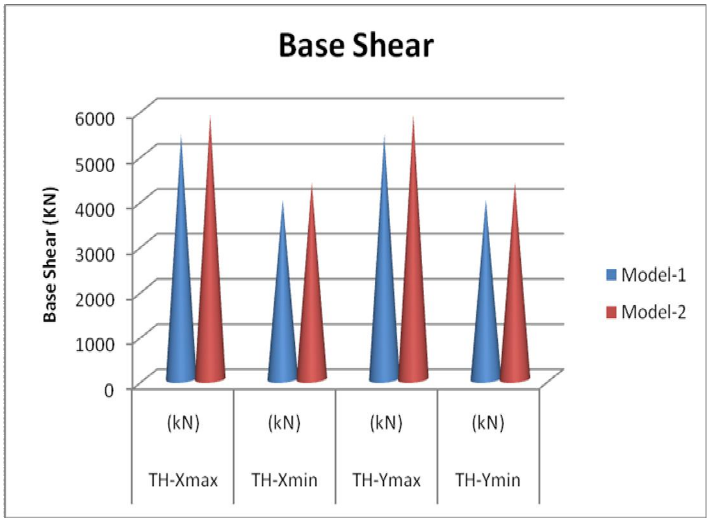


Fig. 8: Bar chart represent of base shear

E. Time History Curve

It is curve to show the performance of a building with respect to time periods. The figure 9 & 10 represents the curve of different models which model 1 and model 2 in x and y direction. The curve is platted in between pseudo spectrum acceleration vs Time periods.

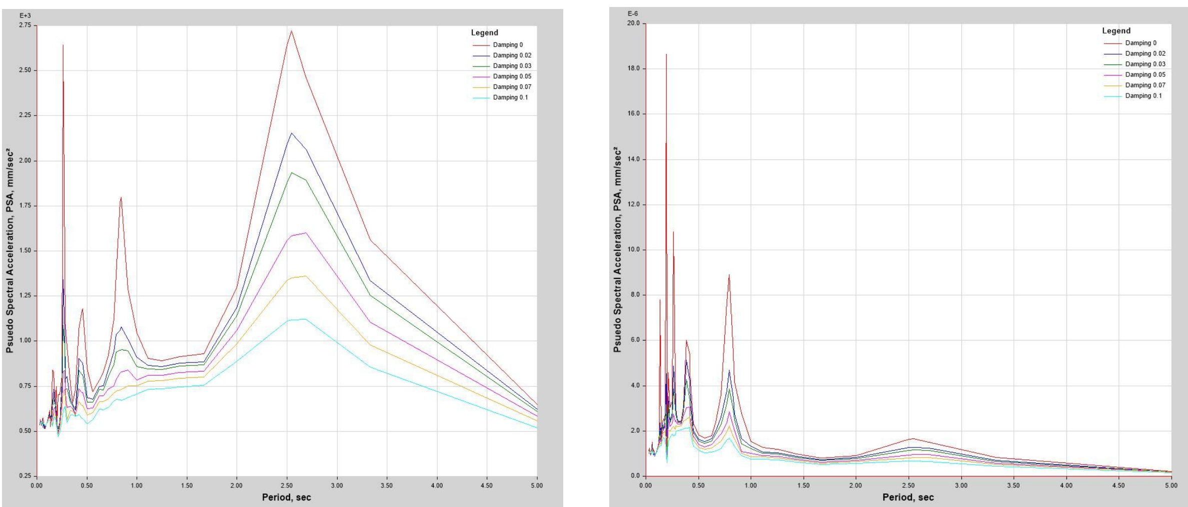


Fig 9: Model 1: Time History Curve for Model-1 in X Direction & Y direction (TH X & TH Y)

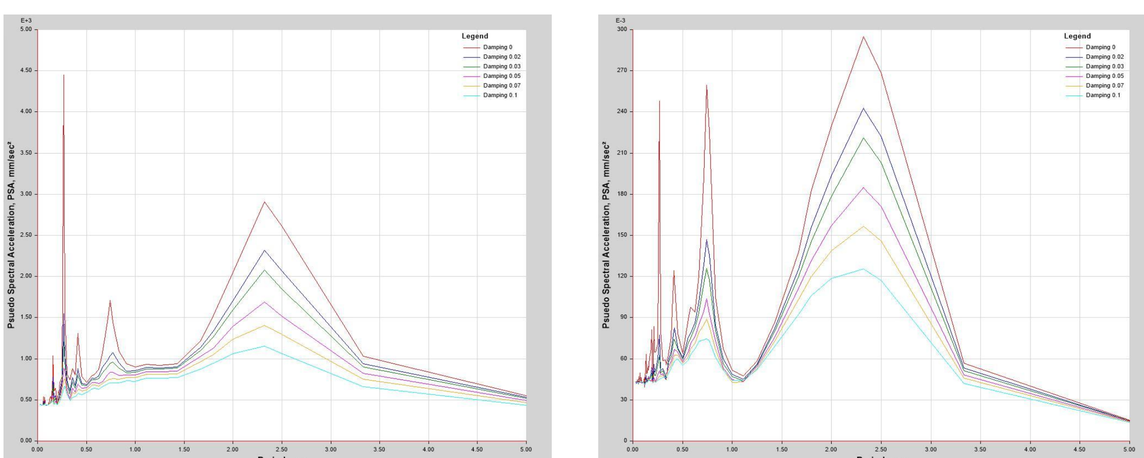


Fig 10: Model 2 History Curve for Model-2 in X Direction & Y direction (TH X & TH Y)

IV. CONCLUSIONS

On The basis of above study on behavior of structural response of flat slab building under earthquake load by fast non-linear analysis for four different structures i.e. Model 1: Flat slab structure with drop panels and without perimeter beams, Model 2: Flat slab structure with drop panels and with perimeter beams; following results are concluded.

A. There is decrement in the displacement of 5.85% in model 2 with respect to model 1. The increment is 0.1 to 5.85% show throughout the ground to G+8 storey in model 2 with reference to model 1.

B. The basement moment value is increases 9.44 % in both TH-X & TH-Y directions in model 2 with respect to model 1.

C. The increment in the base shear value is observed in model 2 due to introduce of perimeter beam in it. The maximum increment is 7.83% in model 2 with respect to model1.

D. The stability is increases in model 2 as compare to model1.

E. The storey shear value will be observed more in model 2 which is avg. 7.67% for all storey level.

F. The dead load also increases the due to perimeter beam is placing in model 2 but the lateral effect capacity increases.

G. The time history curve show that peak acceleration will be decreases in model 2 and the effect is vary with variation in time period. So overall model 2 i.e. flat slab with perimeter used in the lateral stability under earthquake response.

REFERENCES

[1] Khwaja Moinuddin Khan, M. Jeelani (2018) "Analysis and Design of Flat Slabs in Commercial Building by using ETABS Software" International Research Journal of Engineering and Technology (IRJET), e-ISSN: 2395-0056 Volume: 05 Issue: 05, p-ISSN: 2395-0072 2018, Impact Factor value: 6.171, pp- 998-1002.

[2] KathrotiyaMitan, TandelYogendra K., et al. (2018) " Construction Stage Analysis of Flat Slab Structure with respect to Non Linear Time History Analysis using Software Aid" International Journal for Research in Applied Science & Engineering Technology (IJRASET)

[3] Baitule Sayali, Dalawi Tushar (2018) "A Review on Non-linear Pushover Analysis of Flat Slab Building" International Journal of Innovative Research in Science Engineering and Technology (IJIRSET), Vol. 9 Issue 8,DOI:10.15680/IJIRSET.2018.0704107 3903, pp 3903-3906.

[4] Moinuddin Khan Khwaja,Jeelani M. (2018) "Analysis and Design of Flat Slabs in Commercial Building by using ETABS Software" International Research Journal of Engineering and Technology (IRJET) , e-ISSN: 2395-0056,Volume: 05 Issue: 05 , May, p-ISSN: 2395-0072, pp-998-1002.

[5] Kumar Vanshaj, Prof. K Narayan (2017) "Seismic Response Of Multistorey Flat Slab Building With And Without Shear Wall" International Research Journal of Engineering and Technology (IRJET), e-ISSN: 2395-0056 , Volume: 04 Issue: 11, p-ISSN: 2395-0072 IRJET, Impact Factor value: 6.171, pp 573-578

[6] Rajkumar Ch., D.Venkateswarlu (2017) "Analysis and Design of Multi-storey Building with Grid Slab Using ETABS" International Journal of Professional Engineering Studies (IJPRES), Volume Viii /Issue 5 / Jun, PP 79-90.

[7] Faria Aseem, Waseem Sohail, Abdul Quadir (2017) "Analysis and Comparison of R.C.C Conventional Slab& Flat Slab Under Seismic & Temperature Load" International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056, Volume: 04, Issue: 10, p-ISSN: 2395-0072, Impact Factor value: 6.171, Pp- 1370-1376.

[8] Baitul Sayali e, Deshmukh Pratik, et al. (2017) "Performance of Flat Slab Structure with Different Ground Storey Height" International Journal of Advance Engineering and Research Development ,Volume 4, Issue 5, May, Scientific Journal of Impact Factor (SJIF): 4.72 e-ISSN (O): 2348-4470 , p-ISSN (P):2348-6406,pp-994-1002.

[9] Vijay kumar Baheti, Priyanka, Wadje D.S.Wadje, et al. (2017) "Comparative seismic performance of Flat slab with peripheral beam provided infill and shear wall panel at different heights", IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE), e-ISSN: 2278-1684,p-ISSN: 2320-334X, Volume 14, Issue 3 Ver. IV. (May. - June.), PP 27-34.

[10] Bansal Anuj, Patidar Aditi (2016) "Pushover Analysis Of Multistorey Buildings Having Flat Slab And Grid Slab" International Journal of Engineering Science Invention Research & Development; Vol. II Issue VII January 2016, www.ijesird.com ,e-ISSN: 2349-6185, pp 435-441.

[11] Shaga Archana, Polisetty Satyanarayana (2016) "Seismic Performance of Flat Slab With Drop And Conventional Slab Structure" International Journal of Latest Engineering Research and Applications (IJLERA)

[12] Utane S. N., Dahake H. B. (2016) "Effect of shape irregularity on flat slab and waffle slab industrial building under lateral loading" International Journal of Engineering Science and Innovative Technology (IJESIT) ,Volume 5, Issue 2, March, ISSN: 2319-5967ISO 9001:2008 Certified, pp 43-50.

[13] Chiranjeevi Rathod, Ramyakala Sabbineni Ramyakala, et al. (2016) "Seismic Performance of Flat Slab with Drop and Conventional Structure" International Journal of Engineering Research & Technology (IJERT), ISSN: 2278-0181, IJERTV5IS100240, Vol. 5 Issue 10, pp 283-295.

[14] R.R Gagankrishna, S.M Nethravathi (2015) "Pushover Analysis of Framed Structure with Flat Plate and Flat Slab for Different Structural System"International Journal of Innovative Research and Creative Technology (IJIRCT), ISSN: 2454-5988. pp 54-59.

[15] Sharma Anurag, Claudia D JeyaPushpa. (2015) "Analysis of Flat Slab and Waffle Slab in Multistorey Buildings using ETABS" International Journal for Scientific Research & Development(IJSRD), Vol. 3, Issue 02, 2015, | ISSN (online):2321-0613,pp-2483-2488.

[16] H.S Mohana, M.R Kavan (2015) "Comparative Study of Flat Slab and Conventional Slab Structure Using ETABS for Different Earthquake Zones of India" International Research Journal of Engineering and Technology (IRJET), e-ISSN: 2395-0056, Volume: 02 Issue: 03, p-ISSN: 2395-0072, pp 1931-1936.

[17] Hassaballa A. E. , Ismaeil M. A., et al. (2014) "Pushover Analysis of Existing 4 Storey RC Flat Slab Building" Article on International Journal of Sciences: Basic and Applied Research (IJSBAR) · pp 247-257.

[18] More R.S., SawantV. S., et.al. (2013) "Analytical Study of Different Types of Flat Slab Subjected to Dynamic Loading" International Journal of Science and Research (IJSR), ISSN (Online):2319-7064, Index Copernicus Value (2013): 6.14, Impact Factor 4.438, pp 1600-1607.

[19] Priya1K.Soni, T. Durga bhavani, et al.(2012) "Modal Analysis Of Flat slab Building By Using Sap2000"International Journal of Advanced Scientific Research And Technology , Issue 2, Volume 2 (April), Issn: 2249-9954, pp 173-180.

[20] Indian Standard IS 1893 (Part 1): 2016 "Criteria for Earthquake Resistant Design of Structures", part 1 General Provisions and Buildings (Sixth Revision). BIS 2016, Dec. 2016 Bureau of Indian Standards Manak Bhavan, 9 Bahadur Shah Zafar Marg New Delhi 110002

[21] Indian Standard IS 456: 2000 "Plain and Reinforced Concrete Code Of Practice" (Fourth Revision) ICS 91.100.30, BIS 2000, July 2000, Bureau of Indian Standards Manak Bhavan, 9 Bahadur Shah Zafar Marg New Delhi 110002.